RATE CALCULATIONS

FOR

ELECTRIC LIGHT AND POWER

REPORT TO

ST. LOUIS PUBLIC SERVICE COMMISSION

BY

JAMES E. ALLISON,
Commissioner and Chief Engineer

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DEFINITION OF TERMS.

"Cause Theory." The calculation of a rate by distributing the Investment Charge in proportion to the Consumers' Peak Responsibility, or cause of investment. (See page 3 this report, or Part VI, first report.)

"Use Theory." The calculation of a rate by distributing the Investment Charge in proportion to the Consumers' use of the investment or K. W. H. Consumption. (See page 6 of this report, or Part VI, first report.)

"Expediency." The departure from "cost to serve" rates necessary to maintain the output at the point where the lowest cost can be obtained for the consumers as a whole. (See also Part VIII, first report.)

"Investment Peak." The highest point in the yearly load curve. (See pages 3 and 4, first report.)

"Peak Responsibility." The Consumers' share in the K. W. demand on the Investment Peak.

"Customers' Charge." (See page 4, this report, or page 3, first report.)

"Manufacturing Charge." (See page 5, this report, or page 3, first report.)

"Investment Charge." (See page 5, this report, or page 3, first report.)

"Distance Factor." Factor needed to correct differences in investment in distribution equipment to serve different consumers. (Generally not determinable.)

Messrs. Joseph L. Hornsby, Chairman;
James A. Waterworth,
James E. Allison,
Saint Louis Public Service Commission.

Gentlemen:

In submitting to you a report on Analysis of Rate Calculations for electric light and power, dated August 25th, 1910, the writer attempted to show the fallacy of some of the methods of calculation in use for arriving at a measure of "cost to serve" in electric rates.

The principal object of the report was to lay before the Commission the fact that calculations based upon the connected load or maximum demand of the consumer as used, could not be successfully set up as a true measure of the cost to serve the consumer, especially the residence consumer.

The analysis was also intended to show that two methods of distributing the investment charge might be set up, one based upon the investment which the consumer may **cause**, and another based upon his **use** of the investment.

The writer has been misunderstood in some quarters as advocating the Use method alone, or even so far misunderstood as to be advocating a level rate. No one with even a superficial knowledge of the principles and conditions of rate making can think for an instant that a level rate is either practicable or just.

While the Cause Theory and Use Theory are both, to a certain extent, logical, yet calculations based upon them fail of scientific correctness.

First: In that while both the **cause** and the **use** of the investment should be considered in a cost to serve rate, unfortunately there is no logical means by which the relative importance of the two theories can be determined or combined into one calculation.

Second: In that in calculating rates, according both to the Cause Theory and the Use Theory, the differentiation of the rates is necessarily based upon data derived almost entirely from the generating end of the business, and no account is taken of the difference in distribution equipment required by different consumers.

Third: In that the Expediency principle, which is of very great importance, both to the company and to the consumer, cannot be mathematically taken into the calculations.

There is a possible third theory or rather method of calculating rates which in its effect may be said to be a compromise between the Cause Theory and the Use Theory. This method is based upon the theoretical assumption that the operation of the plant and the investment in the plant are entirely separated, just as if the operating department rented the plant from the owners. There is, then, a fixed rent or return assumed upon the investment, and an entirely separate profit or return fixed upon the operation or volume of business. This profit would be charged up to the manufacturing cost in the current, and, being added to each K. W. H. as manufacturing profit, would be distributed among the consumers in accordance with the use or K. W. H. Consumption, thereby in a measure making concession to the Use Theory, the distribution of the investment charge being made by the Cause Theory.

The trouble with this method is, that if in dividing the profit or return between investment and operation we consider the usual percent of return on volume of sales in any staple business, we find that the calculation brings very little difference in results from calculations based purely upon the Cause Theory.

Admitting that there is no absolutely scientific and accurate method of calculating cost to serve

rates, what method is it advisable to adopt to arrive at what may be as nearly as possible just and practicable results?

About the only course left open is to have calculations made by formulae, derived both from the Cause Theory and the Use Theory, and then to take as approximate standards such compromises between these two rates as may be arrived at by judgment alone.

Having these standards, the Commission must again rely to a large extent upon its judgment in allowing concessions to the Expediency principle, and to the distance or distribution investment factor. This last factor being sometimes used as an argument to justify wholesale discounts.

The conclusion that scientifically correct rates for electricity cannot be mathematically calculated is not a welcome one, but it is the truth, and it is much better to know and acknowledge the truth than to follow blindly a false or only partially true formula. Especially is this true in the case of a Public Service Commission charged with the duty of fairness both to the consumer and the company.

While we cannot say that a rate is absolutely correct scientifically, yet with the data available it is quite possible to arrive at rates which will not only be substantially just and perfectly practical, but which can also, in a measure, be defended scientifically.

CAUSE THEORY RATES.

The Cause Theory is based upon the assumption that the investment in plant is made to meet the demand of the highest peak, and that therefore each individual's share in paying the yearly investment charge should be in direct proportion to his peak responsibility, i. e., to his share in this highest or investment peak.

The theory has two decidedly weak points.

First, it assigns all of the investment charge to the consumer or the current which comes on the investment peak, and absolutely none of the investment charge to those consumers or that portion of the current which does not come on the peak.

Second, there is no practical way of determining the Peak Responsibility of the individual consumer, and we are driven in making calculations to use the Peak Responsibility of classes of consumers.

These class Peak Responsibilities may be obtained as described in relation to residence load on page 29 of my former report. It is evident, however, that the segregation of classes of business upon separate feeders, in order to obtain data, may not always be an easy or simple matter.

As pointed out in my former report, the justice of applying class data to the individual is measured by the similarity in shape of his load curve to the load curve of his class.

Fortunately, in two important classes of consumers, residence and power, we may assume that the class load curves and the individual load curves are approximately parallel, at least enough so to assume that there will be no great injustice in assigning to the individual the same K. W. of Peak Responsibility per K. W. H. of consumption as is shown to be right for his class.

Being assured, then, that our data will enable us to get approximately correct results to the individual, according to the Cause Theory, in at least the residence and power classes, we may proceed to develop our formula for the calculation.

First, we take the gross income required to be obtained from the sale of current, which should equal the operating expenses, plus the taxes and insurance, plus the proper depreciation and amortization charges, plus the proper return on the investment. This we call the Total Cost.

This Total Cost we then divide into three parts.

First: The Customer's Charge, which is that portion of the cost caused by the mere connection of the customer, irrespective of his use of current. Costs assignable to this charge being such as the cost of reading the meter, making the bills, keeping the accounts, etc., etc. The charge being the same for each individual consumer.

Second: The Manufacturing Charge, or cost of manufacturing and delivering the current, irrespective of the investment.

Third: The Investment or Demand Charge, consisting of return on investment, taxes and insurance, depreciation and perhaps some of the operating charges traceable to demand.

The selection of the items of expense which should properly be included in the Customers' Charge is a matter of much debate, and according to the mind of the ratemaker, the Customers' Charge may be made to vary greatly.

To obtain the rate for a class (or an individual, if we could get the data) we have the Peak Responsibility of the class obtained as shown in part VII. of my former report, and as the theory assumes that Peak Responsibility is the measure of investment responsibility, the investment charge for the class would be the same decimal of the total investment charge as the class peak responsibility is of the investment peak.

It is also evident that the class charge for manufacturing cost would be the same decimal of the total manufacturing cost as the class consumption of K. W. H. is of the total consumption of K. W. H.

The individual Customer's Charge would be the total Customers' Charge divided by the total number of customers, and the amount of Customers' Charge assignable to a class would be the Individ-

ual Customer's Charge multiplied by the number of customers in the class.

Having, then, the investment cost for the class, the manufacturing cost for the class and the total Customers' Charge for the class, we have but to divide the sum of them by the estimated or ascertained K. W. H. Consumption of the class to arrive at the average rate of the class.

However, as the Customers' Charge should properly be assigned flat to each customer, it is better to so divide the calculation as to give the rate exclusive of the Customers' Charge, and also with the Customers' Charge absorbed.

Reducing to formulae, let

R = Total Cost.

A = Total Investment Charge.

B = Total Manufacturing Charge.

C = Total Customers' Charge.

D = Total Consumption K. W. H.

E = Total Number of Consumers.

P = Investment Peak (K. W.).

A + B + C = R.

r = Class Peak Responsibility (K. W.).

s = Class Consumption (K. W. H.).

t = Number of Consumers in class.

X = Class Rate exclusive of Customers' Charge.

Y = Class Rate with Customers' Charge absorbed

$\frac{r}{P}$ = Decimal of Class Peak Responsibility.

$\frac{s}{D}$ = Decimal of Class Manufacturing Cost Responsibility.

$\frac{C}{E}$ = Individual Customer's Charge.

Then:

$$\frac{\frac{r}{P}A + \frac{s}{D}B}{s} = X$$

$$\frac{\frac{r}{P}A + \frac{s}{D}B + \frac{C}{E}t}{s} = Y$$

When X is used as rate, $\frac{C}{E}$ would be charged flat to each customer.

USE THEORY RATES.

In the Use Theory, we start with the assumption that each consumer should pay investment charges according to the portion of the plant he uses, regardless of whether it is on or off the peak, and also in proportion to the duration of the time he uses it. In other words, for each kilowatt hour of service he pays his prorate of the investment charge as divided among all the kilowatt hours produced during the year.

The weak point in this theory is that it makes no provision for a just charge to the consumer who causes a large investment and contributes a small return toward the general fund for paying the investment charges.

Nevertheless, it does provide investment charges for the off-peak load, which gets the benefit of the investment as well as the peak load.

The formula for calculating rates by the Use Theory is developed by simply taking the total Investment Charge plus the Total Manufacturing Charge and distributing it equally over the total estimated K. W. H. consumption. To this there is

to be added the Customers' Charge, either flat to each customer, or if it is to be absorbed into the rate by classes, the Individual Customer's Charge is multiplied by the number of customers in the class and divided by the K. W. H. Consumption of the class. The result is, the extra charge to be added in absorbing the Customer's Charge into the class rate.

Reducing to formula and using the same letters as in the Cause Theory, we have

$$\frac{A + B}{D} = X$$

$$\frac{A + B}{D} + \frac{\frac{C}{E}t}{s} = Y$$

When X is used as rate $\frac{C}{E}$ would be charged flat to each customer.

Having developed our formula for calculating rates according to the two theories, Cause and Use of the Investment, let us briefly review the points in which they supplement each other.

The Cause or Peak Responsibility Theory, as we see, does not provide that the off-peak load shall pay any of the investment charges. Now, as a matter of fact, the benefit derived by the consumer from the Company's investment or his use of that investment may not be at all in proportion to his peak responsibility. Yet, by the Cause Theory he pays investment charges directly in proportion to it.

For illustration, let us suppose the extreme case of a theater which does not give matinees. Here we would have a large load, no part of which would be likely to come on the peak. It would, therefore, by the strict application of the Cause Theory, es-

cape all investment charges, and if all returns and profits were figured as part of the investment charges, the current would even be sold at exact cost to the Company. The result, we see, is an absurdity, in that this consumer has the use and benefit of large investment which is paid for by some one else. The same reasoning will apply in a measure to all loads having small peak responsibility in proportion to their use of the plant (or K. W. H. consumed), and it will apply inversely to loads having large peak responsibility in proportion to their use of the plant (or K. W. H.).

The Use Theory is the exact opposite of the Cause Theory, in that it considers exclusively the use of the plant made by the consumer, to the entire neglect of his peak responsibility. The one, in a way, supplements the other, and (leaving out of account the Expediency principle and the distance factor) we may assume with as much confidence as is possible in dealing with the kaleidoscopic question of rates that approximate truth is somewhere between the results of the two calculations.

At what point between these two results the approximate truth may lie, must, as stated before, be determined by judgment alone. In such a case there is, unfortunately, very little to base judgment upon. Very fortunately, however, the results of the two calculations when applied to actual facts do not show a wide variation, as is seen by reference to Table I.

In this Table the actual operations of the Union Electric Light and Power Company for the year 1909 have been taken as a basis for the calculation (the street railway business being omitted).

The figures are, of course, only used for illustration, and it is not intended to imply that the rates evolved are either correct or incorrect for producing a proper return.

RESIDENCE RATES.

In Table I. the writer has assumed five different amounts as individual Customer's Charge per year, namely: $6.00, $9.00, $12.00, $15.00 and $18.00 per year per customer; and the Table shows rates calculated under each of these assumptions. It is seen by comparing the results that in residence rates, especially, the Customers' Charge is really the controlling factor in the differentiation of the rate. This fact is shown by comparing the figures opposite "residence" in columns 3 and 8 of the Table, as they appear in the $6.00, $9.00, $12.00, $15.00 or $18.00 Customers' Charge group.

It is seen that a difference of about 4 cents per K. W. H. is made in the average residence rate by assigning $18.00 per year, or $6.00 per year per customer, to this charge. It is evident, therefore, that to obtain an approximately just rate great care must be exercised in selecting those items which can properly be taken into account in making up the Customers' Charge. By loose reasoning on this point it is possible to place a very unjust burden upon the small consumer and upon the residence consumers as a whole.

No item should be accepted unless it is shown to be such as is caused directly by the consumer irrespective of his use of current, and that each consumer is responsible for approximately an equal amount of the item. If this cannot be demonstrated it must be assumed either that the item is one caused in proportion to the use or K. W. H. Consumption, or that it is of such a general nature that it should be assigned in proportion to the benefit in service received by the consumer. In either case the item would properly be a K. W. H. charge.

It has been argued that all the items of general expense such as executive salaries, etc., etc., should be included in Customers' Charge. The basis of

TABLE I.

1	CAUSE THEORY 2	3	Actual Peak Responsibility 4	5	6	7	USE THEORY 8	9	10	11	CONNECTED LOAD THEORY 12	13	I4	15
Customers Charge	Class	Rate	Portion in C. C.	Rate Ex. C. C.	Consumption	Revenue	Rate	Portion in C. C.	Rate Ex. C.C.	Revenue	Rate	Portion in C. C.	Rate Ex. C. C.	Revenue
18.00	Residence	.11829	.06575	.05253	3,256,020	385,154.606	.11054	.0657	.04484	359,943.243	.1998	.0657	.1341	650,552.80
	Power	.03480	.00214	.03266	16,941,726	589,673.715	.04699	.00214	.04484	796,047.656	.05429	.00214	.05215	919,698.538
	Municipal	.03247	.....	.03247	3,460,787	112,369.677	.04484	.....	.04484	155,202.454	.01555	.....	.01555	53,805.548
	Business Light	.05686	.00459	.05227	30,085,014	1,710,754.236	.04944	.00459	.04484	1,487,282.752	.03890	.00459	.03431	1,170,367.215
	Total					2,797,952.234				2,798,476.105				2,794,424.101
15.00	Residence	.10854	.05479	.05374	3,256,020	353,408.411	.10080	.05475	.04605	328,206.816	.1900	.0548	.1352	618,643.80
	Power	.03565	.00178	.03387	16,941,726	604,057.240	.04784	.00178	.04605	810,441.346	.055135	.001785	.05335	934,082.063
	Muncipal	.03367	.....	.03367	3,460,787	116,540.271	.04605	.....	.04605	159,376.162	.01675	.....	.01675	57,979.257
	Business Light	.05730	.00382	.05348	30,085,014	1,724,021.727	.04987	.00382	.04605	1,500,550.243	.03934	.00382	.03552	1,183,643.706
	Total					2,798,027.649				2,798,574.567				2,794,348.826
12.00	Residence	.09879	.04384	.05495	3,256,020	321,662.216	.09106	.04380	.04725	296,493.181	.1802	.0439	.1363	586,734.80
	Power	.03650	.00143	.03507	16,941,726	618,440.766	.04869	.00143	.04725	824,824.872	.05598	.00143	.05455	948,397.821
	Municipal	.03488	.....	.03488	3,460,787	120,710.866	.04725	.....	.04725	163,549.872	.01796	.....	.01796	62,152.966
	Business Light	.05774	.00306	.05468	30,085,014	1,737,289.218	.05032	.00306	.04725	1,513,847.819	.03978	.00306	.03672	1,196,902.197
	Total					2,798,103.066				2,798,715.744				2,794,187.784
9.00	Residence	.08904	.03288	.05616	3,256,020	289,916.021	.08131	.03285	.04846	264,763.266	.1705	.0329	.1376	555,151.41
	Power	.03735	.00107	.03628	16,941,726	632,824.291	.04954	.00107	.04846	839,225.339	.05683	.00107	.05576	962,798.289
	Municpal	.03608	.....	.03608	3,460,787	124,881.460	.04846	.....	.04846	167,727.041	.01917	.....	.01917	66,326.675
	Business Light	.05818	.00229	.05589	30,085,014	1,750,556.709	.05076	.00229	.04846	1,527,115.311	.04022	.00229	.03793	1,210,169.688
	Total					2,798,178.481				2,798,830.957				2,794,446.062
6.00	Residence	.07929	.02192	.05737	3,256,020	258,169.825	.07157	.02190	.04967	233,033,351	.1608	.0219	.1389	523,568.02
	Power	.03820	.00071	.03748	16,941,726	647,207.816	.05038	.00071	.04967	853,622.417	.05768	.00071	.05697	977,232.639
	Municipal	.03729	.....	.03729	3,460,787	129,052.055	.04967	.....	.04967	171,903.519	.02037	.....	.02037	70,500.384
	Business Light	.05863	.00153	.05709	30,085,014	1,763,824,200	.05120	.00153	.04967	1,540,352.717	.04067	.00153	.03914	1,223,437.179
	Total					2,798,253,896				2,798,912.004				2,794,738.222

This table is intended only as an illustration of the effect of customers charge on the rates. Before becoming true rates the Expediency Principle and other elements would have to be taken into account.

this argument is that general expenses increase or decrease directly as the number of customers increase or decrease, and therefore the customers should bear an equal individual responsibility for such charges.

In the first place, the assumption is erroneous. As shown by Table II. (made from the Union Electric Light and Power Company's books), the general expense does not increase or decrease in direct proportion to the number of customers. In the second place, even if it did, that is no demonstration that each customer, regardless of his consumption, is equally responsible for the charge, and the possible injustice of loading up the small consumer with charges for which he may not be responsible is quite apparent.

Table III. shows the variation of general expense as applied to each K. W. H. of output, and it is seen that an argument that general expense increases or decreases with output is quite as tenable as the argument that it varies with the number of customers.

In Table II. the highest point of the charge per customer is 132 per cent of the lowest point, while in Table III. the highest point of the charge per K. W. H. is only 119 per cent of the lowest point, showing that the general expense follows more closely to the variation of the output than it does to variation of the number of customers.

The argument is not conclusive either way, as assignment of items to general expense may be varied with accounting methods.

It is true that certain items and portions of items of general expense may be justly assigned to Customers' Charge, but such items must be carefully sought out and their relation to the customer definitely established.

In cases of doubt, the benefit must be given to the small man, and no "glittering generalities" can

be accepted as ground for swelling the Customers' Charge.

It has been advanced as an argument for high residence rates that the efficiency of distribution for residence load is very low on account of the constant 24-hour iron loss in the transformers, but actual measurements of the all-day efficiency do not show that the efficiency of distribution in residences is less than the average efficiency of distribution for the whole plant.

In other words, actual measurements in the case under consideration do not show that there is greater loss in distributing to residences than to the average business.

Table I. also shows the rates worked out on the basis of distributing the Investment Charge in proportion to the Connected Load by each class, and the results as shown in column 12 tend to prove the writer's contention in his former report that Connected Load is not a proper factor in rate making.

The only reason which can be advanced for using Connected Load as a factor is that it is an attempt to measure the consumer's peak responsibility. Under the Cause Theory in the Table, we show, by another method, rates in which the peak responsibility is obtained, as closely as is possible with existing data. A comparison of the figures in column 3, column 8 and column 12 will show the injustice which might be done, especially to the residence class, by allowing the connected load method of calculation to stand as correct.

No company of any size can, of course, put into effect residence rates based upon a distribution of investment charges in proportion to Connected Load, but the calculation has been used, and will probably continue to be used, until thoroughly discredited, as an argument to justify high residence rates.

UNION ELECTRIC LIGHT AND POWER COMPANY

Comparative Customers' Charge for General Expense for the Years 1905 to 1909, Inclusive.

TABLE II.

	1905.	1906.	1907.	1908.	1909.
Average Number of Customers	10,377	13,495	17,082	19,349	21,966
Executive Salaries	$ 1.722	$ 2.287	$ 2.824	$ 1.718	$ 1.093
Clerical Salaries	2.656	2.796	2.768	1.959	1.971
Stationery and Printing	.431	.155	.298	.543	.510
General Office Expense	1.058	1.010	1.236	.877	.862
Legal Expense	.349	.576	.886	1.518	1.280
Injuries and Damages	.124	.245	.888	1.578	1.392
Public Service Commission Investigation	.....	.....	.....	.....	.022
Incidental Expense	.445	.288	.288	.556	.295
Promotion of Business	5.665	6.853	5.412	5.401	3.605
Total General Expense, Per Customer	$ 12.450	$ 14.210	$ 14.600	$ 14.150	$ 11.030

Table I. shows, in columns 7, 11 and 15, the portions of the revenue to be produced from each class under the different theories and by the different assumptions of Customers' Charge. The total revenue in each case should be the same, but the figures in the Table vary slightly, owing to the calculations not being carried out beyond three, four or five decimal points in some of the factors.

Column 5 in Table I. shows the average class rate under the Cause Theory which would be paid per K. W. H. provided the Customers' Charges were assessed flat to each customer, and column 10 shows the same charge under the Use Theory.

The assessment of the Customers' Charge flat to each customer is the theoretically correct and just plan for distributing that part of "cost to serve" among the customers, but on account of the extreme unpopularity of any flat charge there are very serious questions of policy involved in deciding whether to assign the Customers' Charge flat to each consumer or to absorb it in an average class rate.

If our assumption is correct that individual residence load curves are approximately parallel to the class curves, then the rate under either the Cause or Use Theory (with the exception of the differentiation caused by the customer charge) should be the same for all consumers in that class, unless the application of the Expediency principle is shown to be necessary. A study of the classification of customers, according to consumption, as compiled for the Commission, shows us that in the residence class there are practically no really large consumers, and the number who are enjoying appreciable discounts for quantity would not materially affect the business, even if they betook themselves to other sources of light. As a matter of fact, the large consumer of residence light is the most un-

UNION ELECTRIC LIGHT AND POWER COMPANY

Comparative General Expenses for the Years 1905 to 1909, Inclusive, Per Kilowatt Hour Output.

TABLE III.

	1905.	1906.	1907.	1908.	1909.
K. W. H. Output	34,982,288	43,856,276	64,641,843	62,518,540	64,569,775
Executive Salaries	$ .0005110	$ .0006592	$ .0007088	$ .0005314	$ .0003718
Clerical Salaries	.0007880	.0008054	.0006946	.0006060	.0006708
Stationery and Printing	.0001278	.0000447	.0000751	.0001682	.0001737
General Office Expense	.0003139	.0002912	.0003103	.0002713	.0002935
Legal Expense	.0001036	.0001658	.0002224	.0004695	.0004357
Injuries and Damages	.0000369	.0000707	.0002228	.0004886	.0004736
Public Service Investigation					.0000077
Incidental Expense	.0001322	.0000829	.0000724	.0001721	.0001009
Promotion of Business	.0016809	.0019741	.0013579	.0016717	.0012268
Total Gen. Ex. per K. W. H.	$ .0036943	$ .0040940	$ .0036643	$ .0043788	$ .0037545

likely person to discontinue service on account of price.

It can therefore be concluded that the Expediency principle is not applicable to the residence class unless it can be shown to be both just and necessary that this class should be burdened with some of the costs of other classes of consumers.

If the last condition is not admitted we can conclude that the results arrived at from the use of the formulae will give very closely the correct rates for residence light.

POWER RATES.

In considering the rates for power we can assume that, generally speaking, there is a similarity between the individual customer's load curve and the load curve for the class, and that therefore a similar K. W. H. rate applied throughout the class would be approximately just, but in this class the Expediency principle becomes a powerful factor in deciding the proper rate, as there are many large users who would be driven to other sources of power if charged the average rate for the class. The enforcement of such a rate might, and probably would, cause a very appreciable loss in volume of business, with the result that the remaining consumers would be compelled to pay more than would be the case if the rates were adjusted to meet the conditions.

It will, therefore, probably be found, for the benefit of all, that the Company be allowed to charge a rate in some cases higher and in some cases lower than the average class rate.

MUNICIPAL LIGHT.

In considering the rate for Municipal lighting, the Commission is confronted with the existence of a long-time contract which cannot be changed. The only course, then, is, if the charge is found too high, to shift the surplus return to the benefit of the

other consumers. If the rate is found to be too low, the deficit must be shouldered by the other consumers.

It is seen here that under strict regulation it is to the disadvantage of the general consumer for the City to pay too low a rate for Municipal light. It is, however, to the advantage of the taxpayer that the City obtain as low a rate as possible.

BUSINESS LIGHT.

In the foregoing classification of consumers into Residence, Power and Municipal, it has been assumed with what seems probable correctness that the load curves of the individual consumer are in most cases approximately parallel to the class load curve and that therefore the application of the class rate to the individuals (taking Expediency into account in Power rates) will bring about rates as nearly correct as can be expected in dealing with a subject having so many necessarily neglected factors. But in making the classification which we call Business Light we have included therein all consumers other than Residence, Power or Municipal. This is really no classification at all, and the average rate evolved for this Business Light class is merely the average rate for the balance of the business after deducting that of the first three classes from the whole.

The multiplicity of uses, demands and conditions included in the class, and the very meager data at present available for determining the actual peak responsibility of the different kinds of consumers, prevents the application to the individual of the average class rate calculated by the Cause Theory or peak responsibility. This same meagerness of data renders the division of the Business Light consumers into accurate classification as to peak responsibility, a practical impossibility beyond a few rough subdivisions.

It will probably be possible eventually to so divide Business Light into sub-classes in accordance with parallel load curves as to obtain satisfactory rate calculations under Cause Theory for a great number of consumers, but to carry out the experiments necessary for obtaining the requisite data will probably require several years' time.

In applying the Use Theory, however, we have all the necessary data, for in this calculation the individual consumer pays investment charges in accordance with the service rendered him, or by his K. W. H. consumption as shown by his meter readings. But while this calculation may be correct for the individual so far as it goes, we have no means of determining how far the result should be modified by his peak responsibility, i. e., by the Cause Theory.

In this class also it will be found that the Expediency principle is a very powerful factor, and that undoubtedly if a strictly average cost to serve rate were adhered to, large portions of the business would be lost, causing in the end an increase in rate to those consumers who would remain.

What, then, must be done, for the problem must be solved in some way?

The writer would suggest that after eliminating from the class certain obviously exceptional subclasses, the Commission fix a maximum class rate somewhat above the average class rate, to compensate for reduced rates made to meet the varying conditions of "expediency" and "cost to serve." From this maximum rate for the class such variations must be made, by discounts or wholesale prices, as may seem best to fit the existing conditions; having always in mind that the class as a whole must produce the amount of income assigned to it in the class rate calculation.

WHOLESALE RATES.

In the former report on Analysis of Rate Calculations the writer has taken the position that wholesale rates **per se,** are not justifiable in the charges of a public service corporation (see page 38, Report August 25th, 1910), and that differentiation of rates can only be justified on the "cost to serve" or "expediency" principles. This position seems theoretically correct. But in devising some plan by which the Company may meet the existing conditions in the application of these two principles to Power and to Business Light, the Commission finds itself confronted with the alternative of allowing rates or contracts to be made especially for certain individual consumers, or of establishing some scheme for wholesale rates or discounts to roughly meet the requirements of the situation.

It seems unavoidable, then, that here, as at many other points in rate making, theory must be sacrificed somewhat for the sake of practical results, for it is an established principle that in public service there should be no opportunity for personal discrimination, and that rates and schedules should be published and should apply to any or all consumers who comply with the conditions.

Apparently, about the only possible plan for meeting this situation is by some system of wholesale prices, although it is evident that so soon as we institute concessions or discounts on account of quantity alone we lose sight of actual "cost to serve."

We can, however, obtain some guide to the proper application of the Expediency principle by inquiring what low prices must be established to prevent power and light of large consumers being transferred to other sources than the central station to such an extent as to injure the whole body of the remaining consumers.

The question, to a great extent, is to determine what are the competing sources of light and power, at what quantity of consumption the competition begins, what prices must be made to meet this competition and at what point it is to the best interest of the consumers as a whole to allow the business to be taken from the central station company. Data on these points is now being collected for the Commission and will be submitted when required.

Having fixed these competing points in the rates, and having decided upon the quantity of consumption at which they become effective, it remains to make such compensating allowance in establishing the maximum rate as will insure the proper income from the whole class.

The writer is aware that the study of this and the former report on rate calculations shows that rate making is not an exact science, yet a review of the conclusions to be drawn from both reports makes it apparent that certain rates may be calculated with at least approximate accuracy and justice.

Recapitulating from the former report and adding conclusions to be drawn from present report, we have the following:

CONCLUSIONS.

First: Neither the Connected Load nor the Maximum Demand of the consumer are rational factors to enter into Cost to Serve rate calculations.

Second: If the Use Theory alone is applied, the Investment Charge will distribute itself into a level K. W. H. charge, and the only differential element will be the application of the Customer Charge.

Third: There is at present no practical method of obtaining data for calculating **individual** Cost to Serve rates according to the Peak Responsibility or Cause Theory, and any calculation on this theory must be based upon Class Factors.

Fourth: For the general good of the consumers it may be necessary to modify Cost to Serve rates on the Expediency principle.

Fifth: By using the records of feeders on which certain classes or portions of classes have been segregated, it is possible to obtain satisfactory data as to the class peak responsibility for some classes.

Sixth: On account of close similarity in results of Cause Theory calculation and Use Theory calculation, there is no great difficulty in assigning rates taking both theories into account.

Seventh: Customers' Charge is an exceedingly important factor in establishing residence rates, and items admitted to the charge need to be closely scrutinized.

Eighth: In Residence Lighting it is possible to reach tolerably accurate results under both Cause Theory and Use Theory, and these rates are justly applicable to the individual.

Ninth: Corect Power rates can be calculated, but will have to be adjusted to meet "Expediency" conditions.

Tenth: In the Business Light class, Cause Theory rates for the variety of services under that head cannot be calculated closely with present available data, but Use Theory rates must be taken as a base to work from, and adjustments made according to judgment and "expediency" conditions.

Respectfully submitted,

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